GORDON

The Determination of Equitable Water rates for Municipalities

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THE DETERMINATION OF EQUITABLE WATER RATES FOR MUNICIPALITIES

BY

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

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ENTITLED THE DETERMINATION OF EQUITABLE WATER RATES FOR MUNICIPALITIES

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Bachelor of Science in Municipal and Sanitary Engineering.

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CONTENTS.

CONTENTS (concluded).

THE DETERMINATION OF EQUITABLE WATER RATES FOR MUNICIPALITIES.

I. INTRODUCTION.

The question of the determination of equitable water rates for municipalities is one sometimes confronting the engineer engaged in municipal work. Although it is not especially difficult to determine what is a fairly equitable rate, yet in the working out of the details there are many points on which engineers do not agree. It is the purpose of this thesis to discuss the methods of determining equitable rates and to give an example showing the application of these methods.

The calculation of water rates may naturally be made from either the producer's or the consumer's point of view. If it is made from the producer's point of view, the producer may be regarded as entitled to a fair return upon the investment which he has made in the plant, over and above current expenses, taxes, depreciation and cost of service. The consumer's point of view is that he should be charged no more for the water than it is worth to him. In other words, that he should pay no more for the water than it would cost him, if he were to build his own plant and supply himself, after adding a fair amount for interest and profits. It is seen that these two different ways of arriving at a rate adjustment differ in the element of time. The producer is estimating his rate from the standpoint of a plant built sometime in the past while the consumer is estimating his rate from a plant duplicating the producer's plant but built at the present time. Another way in which these plants may differ is that of construction. The producer knows or should know what it cost him to erect his plant and to maintain it. However carefully the consumer may figure the cost of a duplicate plant, unforeseen conditions might be such that the plant could not

be built for anything near the figure estimated by the consumer.

If we consider that the consumer will figure on the same scale of prices as were in effect when the producer built the plant and that the same engineering ability and foresight will be used, then the two methods may be regarded as the same and rates may be figured from either standpoint. There are plants whose cost of construction would make water rates yielding a fair return on the investment almost prohibitive, but these are exceptions to the general rule and will not be considered in this thesis.

II. DETERMINATION OF FAIR INCOME.

Equitable water rates must be such as to include, current expenses, interest and profits.

A. CURRENT EXPENSES.

Current expneses may be divided into the three heads, operating expenses, taxes and depreciation.

(a) OPERATING EXPENSES.

Operating expenses will of course be made up of different items in different plants for all plants are not built alike or operated alike, but the following general expenses will occur in most plants: cost of fuel or power, oil, waste, labor and office expenses, including reading of water meters, bookkeeping, management, insurance, and such minor expenses as stamps, paper, pencils, telegrams, etc. It should be understood that the plant must needs be run in the most efficient and practical manner, otherwise the expenses figured in the rate making must not be the actual running expenses but must be the calculated expenses under a proper and efficient management. The question of determining whether a plant is efficiently managed or not requires experience and good engineering judgment. An engineer making such an investigation must examine

the salaries paid employees, he must scrutinize the general method of handling all accounts, he must also examine the prices paid for fuel, power, etc., and determine whether these are as low as could be obtained in that particular locality. In case the engineer decides after a thorough investigation that the plant is conducted in an efficient manner, then the operating expenses may be obtained from the company's books.

(b) TAXES.

Taxes are an item which necessarily enter into current expenses and may be obtained either from the company's books or from the tax collector's records.

(c) DEPRECIATION.

Depreciation may be regarded as divided into two parts; physical depreciation and functional depreciation. Physical depreciation represents the loss in efficiency and durability due to wear and tear, while functional depreciation represents the loss in efficiency due to the inability of the machine or structure to meet the demands of the services required of it like some new machine or structure would. An illustration might make this idea clearer. The advance in the design of generators and motors in the last few years has been so great that, every year, many machines are sent to the scrap pile, not because they are worn out but simply because they are not able to perform their duties as efficiently as machines of newer design would and then it is proper economy to discard them. In order to obviate the necessity of adding more capital to replace worn out parts of a plant and the plant itself as it becomes useless, a fund should be set aside each year for such replacement and it is quite just to regard it as an annual expense to be borne by the consumers.

(1) Calculation.

The amount necessary to add yearly to the depreciation fund may be calculated in three ways.

(a) Sinking fund method.

(b) Constant rate method.

(c) Individual analysis method.

(a) Sinking fund method.

In this method the life of the structure is estimated and the amount of money which if placed at compound interest at the end of each year will give the sum necessary to replace the structure when worn out is ascertained. Of course a waterwork plant is made up of a great number of parts, some of which depreciate rapidly while others suffer very little depreciation, so in order to determine the total amount of the sinking fund each part of the plant must be considered separately and the life, rate of interest, and share of the fund calculated.

(b) Constant Rate Method.

The constant rate method consists in the annual addition of a sum equal to the value of the structure to be replaced divided by the estimated life of the structure.

(c) Individual Analysis Method.

This method consists in charging off lump sums to replace machines or structures as these become useless.

(2) Discussion.

It is readily seen that the sinking fund and constant rate methods are the more satisfactory to directors and stockholders in a water company, since either of these methods permits steadier dividends than the individual analysis method. The sinking fund method is usually more popular than the constant rate method since

it corresponds more nearly with the actual depreciation of the structures themselves. In the first few years the parts and appurtenances of a plant will depreciate very little in value, in fact some of them may become more efficient than they were when erected due to the increased smoothness of working parts. At this time the sinking fund will increase slowly, but as the years go on, and as the parts become worn out, the sinking fund will increase quite rapidly. Because of this close parallelism between the actual physical part and the fund which is to replace it when worn out, the sinking fund method has become quite popular as a means of calculating depreciation and is used in most water work valuations and rate decisions at the present time.

B INTEREST ON PLANT.

(a) RATE OF INTEREST.

The interest rate on any water work investment will vary with two factors, first the hazard involved in the investment and second the closeness of the site of the investment to the money markets. The hazard involved in the investment will depend upon several different things each of which will be discussed in some detail.

Probably the most influential factor in determining the hazard is the question of franchise. There are almost as many different kinds of franchises granted to water companies as there are municipalities for the granting of them. Some of them are for a short period of time, ten or fifteen years, others are for from twenty to thirty years while some may be for ninety-eight years or may be perpetual franchises. Some franchises reserve the right to the city of taking over the water company's plant after a period of years at a valuation determined by an impartial board, some are

exclusive, that is they guarantee the water company no competition, while others make no provisions regarding competition. Many franchises fix the maximum rates which the water company may charge and these rates if low would tend to increase the interest rates. A short time franchise, a franchise granting the city the right to take over the plant and one guaranteeing nothing regarding competition will all tend to increase interest rates, while perpetual franchises, franchises guaranteeing no competition, and franchises granting immunity from municipal control all tend to lower interest rates. The geographical situation of the town, and its suitability for the growth in population affect the hazard involved and consequently the rate of interest.

The way in which the closeness of the site of the investment to the investor affects the rate of interest does not need much explanation. People are always willing to invest money at lower rates of interest at home than at a distance. Taking into account these factors just mentioned and current interest rates it would seem that the rate of interest to be used might well lie somewhere between five and eight per cent. The lower figure is about the minimum, since investors receive as much as four per cent from savings banks and the risk involved in bank deposits is admittedly much less than the risk involved in waterworks undertakings. The upper figure is not so easily checked but for investments in the east and in the middle west eighty per cent may be regarded as almost a maximum for any investment. In the following table the views of several authorities regarding the rate of interest to be used will be given.

AUTHORITY	RATE OF INTEREST	SOURCE OF INFORMATION
F. C. Coffin	5 %	Trans. Am. Soc. C. E. Vol. 38 P. 190
W. Kiersted	6 %	Trans. Am. Soc. C. E. Vol. 38 P. 122
C. Palmer	5 %	Trans. Am. Soc. C. E. Vol. 38 P. 159
Supreme Court, Pa. Justice Williams.	Not less than legal rate of interest	Brymer vs. Butler Water Co. 179 Pa. 231
L. Metcalf*	5-6 %	Trans. Am. Soc. C. E. Vol. 64 P. 35
C. C. Young°		Eng. News Vol. 65 P. 141

6 % Extensions of large properties showing substantial surplus earnings.

7 % Extension of large properties showing small surplus earnings.

8 % Extension of small properties showing substantial earnings

9 % Extension of small properties showing small earnings.

10 % On new properties when the estimated net earnings for the first year of operation are from 8 to 10 % on the total cost of organization, construction and development.

12 % On new properties when the estimated net earnings under accepted methods would not pay 5 % on the cost of organization, construction and development during the first three years but where ultimately it is estimated the property will earn good dividends.

* For New England.

° Profit and interest are not separated in these estimates.

In the Madison Gas and Electric case before the Wisconsin Railroad Commission, the commission allowed an interest rate of six per cent.

(b) VALUE OF PLANT.

The value of the plant is usually considered as made up of the value of the buildings and structures, the going value and the working capital.

(1) Value of Buildings and Structures.

Methods of estimating.

Probably no subject connected with rate making or valuation has been so much discussed as the methods of valuation of buildings and structures of water plants. Three prominent methods have been advocated by engineers and court decisions: first, the capitalization of gross earnings less operating expenses; second, the original cost of construction less the depreciation; third, the cost of reproducing the plant.

(a) Capitalization of gross earnings less operating expenses.

Outside of the fact that this method is perhaps the easiest way of arriving at a valuation of a plant, it has nothing to recommend it. It presupposes that the water rates are just rates and that the net earnings of a plant will remain constant for a period of two or three years. It is readily seen that a slight change in either the rate of interest adopted for the capitalization or in the amount of the net earnings will produce quite large changes in the money value when capitalized. Good office management combined with the failure to keep works in proper repair may swell the net earnings and then inflate the assumed value far above the true value. Although this method has been used for waterworks valuation it is hardly suitable for rate making since it is based upon a sup-

position of proper rates. One could hardly use it to determine the value of the plant and then expect the value of the plant as determined to reflect the just water rates.

(b) Original cost of construction less depreciation.

This method of determining the value of a physical plant is only slightly better than the method just discussed if it is better at all. In only a few cases is it possible to secure the records of the costs of construction including engineering expenses, interest on money invested while building, and the legal expenses. If these are secured and the depreciation determined the question arises as to whether this amount represents the true value of the plant at the present time or not. It seems hardly fair to the public to have the value of the plant taken as that represented by construction costs during a period of very high prices both for materials and labor, nor does it seem fair to the public to ask it to accept mistakes along engineering lines, errors in estimating the future growth of the town and general mismanagement during construction, as part of the value of the present plant.

On the other hand it is not equitable to the company to ask them to accept a lower valuation for their plant resulting from the use of the best engineering judgment during construction and from advantages which they may have secured in the purchasing of materials for the construction of the plant. The present owner of the plant may have had nothing to do with the plant's construction but still he must accept a valuation based upon the cost of construction. Consider the question from the standpoint of a willing seller to a willing buyer. The seller wishes to dispose of his plant for the largest amount which the buyer will give. Is the buyer interested in what the plant originally cost or for that matter is the seller

figuring his selling price from the original cost of the plant? The buyer will pay no more than it would cost him to duplicate the plant while the seller realizes that his price is really in competition with the cost of duplicating his plant at that time and thus values it accordingly. It would then seem that this method of determining the valuation of a plant is hardly satisfactory, but it is quite valuable as a means of checking other methods or as an aid in the use of the other methods. When the construction of a plant has been carried on in the proper manner and the plant is but a year or so old this may become the best method of making the determination.

(c) Cost of Reproduction.

(1) Estimation.

The cost of reproduction is at the present time the most favored of all methods of making waterworks valuations and it should justly be so. In actual sales the value arrived at more nearly approaches the value determined by this method than the value determined by either of the other two methods although either of the first two methods may in certain cases give approximately the same results.

In order to determine the cost of reproduction new a complete inventory, or more properly a physical history of the plant is necessary. Not only should all existing structures be included in this inventory but any temporary structure found necessary in the original construction of the work. Difficulties encountered in construction, such as wet soils, treacherous foundations, quick sand and other unusual conditions should all be known and should be included in this physical history. After all these facts are known it is necessary to determine what unit prices should be used in

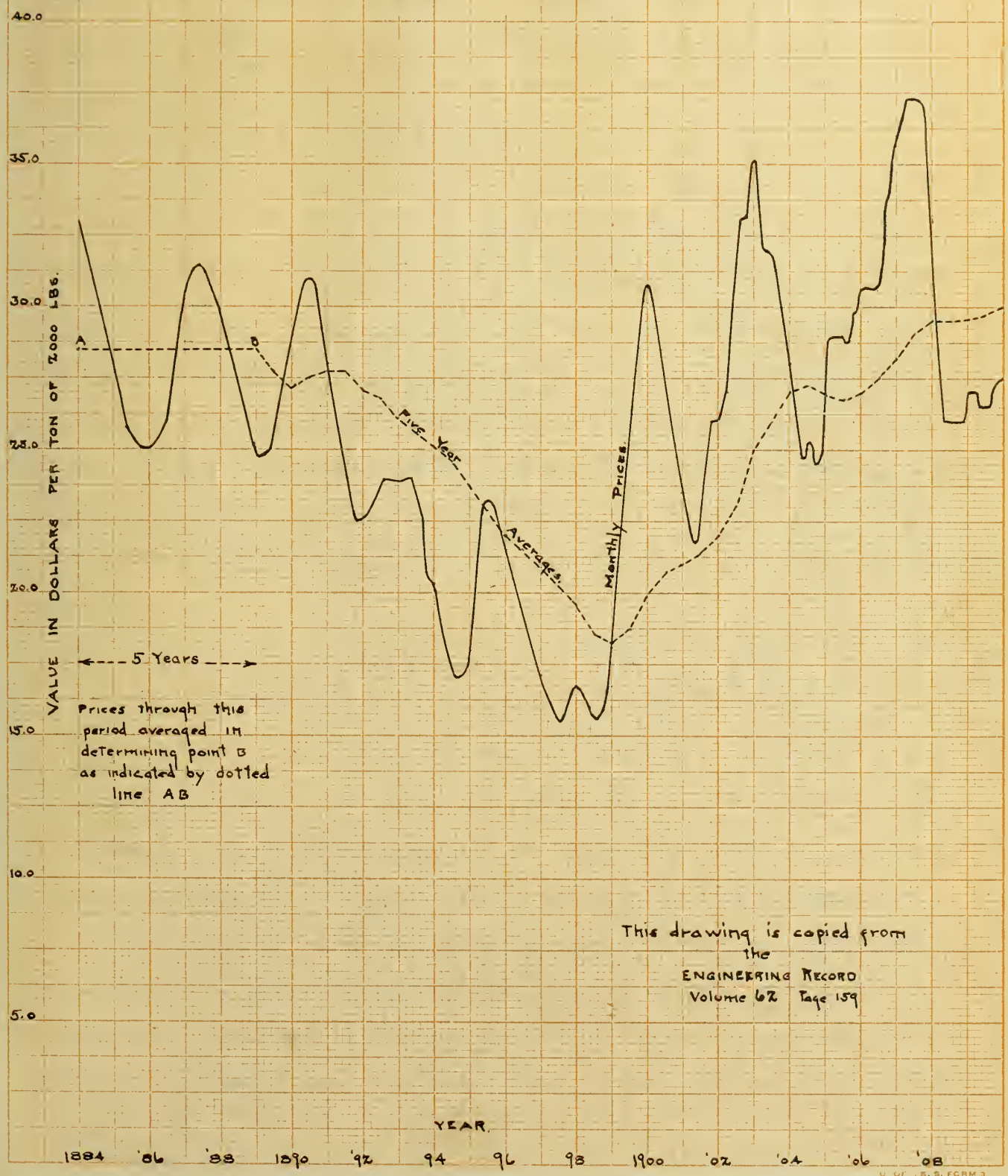
computing costs.

(2) Unit Prices.

There are several different opinions concerning the unit prices which should be used. Decisions of Maine courts in the past have prescribed that prices corresponding to those existing at a time before this valuation equal to a length of time required to build the plant should be used. These decisions have been made on the assumption that the work has been started in time to turn the completed plant over at the time of the appraisement. In the case of the National Water Works Company vs. Kansas City, 62 Federal Reporter, 853-869, the court ruled that prices prevailing upon the date of the taking were to be used, upon the theory that the valuation was made as to the date of taking and so the prices of that date should be used. With regard to this question the Railroad Commission of Wisconsin says the following: "In the light of critical and extensive studies covering the full range of physical properties involved in the work of the commission's valuation staff, supplemented by numerous conferences and discussions with experts, some interested others entirely disinterested, the opinion is here recorded that the practice followed by the staff in fixing unit prices accomplishes the result demanded in this valuation work, namely, valuation figures which correctly and justly represent cost of reproduction now under what may be called ordinary or normal conditions". The Commission further says: "Any measure of rates should be permanent for a reasonable length of time otherwise it will be entirely impracticable. If the standard by which the reasonableness of charges is to be determined should fluctuate with the market prices of material, labor and land, no schedule of

rates could be established for any length of time, for, under the circumstances a rate that might be reasonable today might be very unreasonable tomorrow. The principle of the law applied to the subject certainly involves no such absurd consequence". The accompanying diagram taken from the report of the Wisconsin Railroad Commission on the Appleton, Wisconsin case will indicate the fluctuations in the price of cast iron--usually the biggest factor in the reproduction of a physcial plant--over a period of years, and serves admirably to back up this argument. The quotations on cast iron pipe fell from $37.00 per ton in August, 1907 to $26.00 per ton in April 1908. Could any reasonable or fair minded person be convinced that water rates for a municipality should fluctuate in this way in a short term of nine months?

Monthly Prices for Cast-Iron Water Pipe and Averages for a Five Year Period



This drawing is copied from the Engineering Record Volume 62 Page 159

Mr. F. E. Turneaure in his valuation of the Davenport Water Company's plant has seen fit to use a five year average extending over the previous five years. Leonard Metcalf in his article on "Water Works Valuations and Fair Rates" given in the Transactions of the American Society of Civil Engineers says: "A reproduction cost based upon normal or average prices for a period of years prior to the date of taking would be a fairer criterion than one based upon the monthly or daily fluctuation of the material and labor market".

It seems fairer therefore in making a valuation of a plant to adopt the prices ranging over a period of years, for this assures the company that the valuation of their plant will be but slightly different a month, or a year from the time of valuation and that it will tend to increase or decrease along with the prices of other commodities. It assures the public that the rates are not based on whatever price a very changeable commodity happened to be at the time of valuation but that the rates are based on an average price which will usually reflect prices of other goods, although it may not necessarily do so.

(3) Special Items.

Pavements--In determining the cost of reproduction now the question often times arises as to whether the company is to be allowed anything additional for mains laid under pavements when the construction of the pavements has been subsequent to the construction of the water mains. The Wisconsin Railroad Commission has decided that although the water company should be allowed the cost of repairs necessitated by cutting through the pavements it should not be allowed to capitalize public improvements for its own benefit. The decision in regard to this is so well stated that it

is included in this thesis. "Every legitimate expenditure in adapting the utility to the demands of progress and the community growth is a proper charge to construction and as such the investment therefore is entitled to participate in the distribution of earnings from operation. Obviously expenditures for pavement incurred by the utility in response to assessments levied therefor by the city or the cost of cutting through such pavements for construction purposes and its replacement are proper capital charges. It does not necessarily follow that the utility is to capitalize expenses for municipal betterment in which it has not participated and when such accruing benefits to the community are remote and incidental and then compel the subscriber to pay increased rates because of public improvement. This improvement is not a proper element of value when the pavement has not been paid for by the utility nor any expense in connection with it directly incurred, in determining a value which shall serve as a basis in the adjustment of rates".

Land--The valuation of land is ordinarily made from present real estate values, the value of similar land in the immediate vicinity being taken as an index. Cases might possibly arise in which the land occupied by a water company should become extremely valuable due to the development of unknown natural resources in the vicinity or to the advantage of its natural location for business or manufacturing interests. If cheap land suitable for the water company's purpose is at hand, the value of the land used as a basis for rate calculation can hardly be taken as that of the company's present site while if this land owned by the company is the only available land for water purposes then the valuation of this particular land must be taken.

Interest, Legal and Engineering Expenses. In determining the reproduction cost of a plant, interest during construction, legal expenses and engineering expenses must all be included. The engineering expense is usually about five per cent of the cost of construction. Often these expenses are grouped together and the total value taken around twelve per cent of the reproduction cost of the plant although it may vary from nine to fifteen per cent for different plants.

(2) Going Value.

Going value may be defined as the cost of building up a business to the point where it will pay interest and a reasonable profit on the money invested. Investors in public utilities realize that, for a longer or shorter period of time after a plant is built and in operation the returns will not be sufficient to meet operating expenses, interest, profits and depreciation and that more capital must be supplied to care for the deficit. The cost then of placing a concern on a going basis is fundamentally as much a part of the reproduction cost of a plant as is the cost of installing pumping engines or any of the other machines necessary for the successful operation of the plant.

The Wisconsin Railroad Commission in ascertaining what value may properly be taken as the going value of water concerns has assumed it equal to the deficit in operating expenses, advertising and other expenses dependent upon the building up of the business to the point when the deficit no longer occurs. Leonard Metcalf and John W. Alvord in an article in the Transactions of the American Society of Civil Engineers advccate a method differing from that of the Wisconsin Railroad Commission. They have named their method the "Comparative Method" because of the comparison between a hypo-

thetical new plant and the existing plant. Briefly stated, this method is as follows: "The comparative plant is assumed to be built beginning with the date of valuation, or taking, and to acquire business up to the level of the existing company as rapidly as possible. The sum of the per cent worth of the annual excess in returns of the existing plant over the hypothetical or comparative plant, in the period of years from the date of taking to the time when the earnings of the comparative plant are assumed to become identical with those of the existing plant, represents the going value of the existing plant". The authors of the comparative method advance the argument that since a determination of the value of the physical plant is made from the reproduction cost, therefore, the going value of a plant should also be estimated from the hypothetical growth of an assumed new plant. Although this argument is basically sound still there are many disadvantages in the way of its practical extention. Only the most experienced engineer would be capable of carrying out this method in such a manner as to assure justice to both sides. The operating expenses for each year after the assumed start of the plant, the amount of advertising necessary, the growth in number of consumers, and the per capita consumption must all be estimated. Naturally in estimating such an uncertain proposition the books of the company would be consulted to determine the manner in which the business was built up and so it seems that it would be better to use the Wisconsin Railroad Commission's method in the first place and get the actual expense. The objection may be raised to the Wisconsin Railroad Commission's method that in case of unwise advertising, a value is found for the going value which represents unwise expenditures on the part of the original investors and which could not properly be a part of the basis for rate determina-

tion. Then too, if the company has built up its business very slowly and has charged very high rates, the going value as determined by the Wisconsin Railroad Commission's method will naturally be much higher than it really should be. When cases occur such as the one just mentioned it would no doubt be better to combine the two methods and then use the best part of each. In the majority of cases, however, the Wisconsin Railroad Commission's method will be found the most practical way of arriving at the going value.

(3) Working Capital.

The working capital is the amount of cash which is necessary to conduct the business of a plant and which must be at hand at all times. Since it must be advanced by the investors the same as money for actual building expenses, it is a part of the investment and in rate making earnings must be allowed on it. The amount of the capital varies somewhat with the manner in which the business is conducted. If water rates are paid at the same time that salaries are paid it will be smaller than if water rents are paid quarterly and salaries are paid every two weeks or every month.

C. PROFITS.

The last factor to be discussed in the determination of fair income is that of profit. It hardly needs to be stated that unless some inducement is offered above mere interest, people having money to invest will not build water works for municipalities. The chance of profit is what spurs investors and promotors to supply the public with the necessities and conveniences of life and it is but proper to encourage anything which contributes to the public welfare. Profits may be regarded in the same way as interest, that is, as a percentage on the total investment. It is not easy to state what per cent should be allowed as profit but in general, the

rate of profit varies about as the ratio of interest at different localities. Like many other problems connected with the determination of equitable water rates the best of engineering judgment and experience is needed. Careful study should be made of the profits accruing to investments of like nature under similar conditions and to features distinguishing any of these investments from the others. In most cases the fair profit to be allowed will vary from five-tenths to three per cent.

III. RATE DISTRIBUTION.

A. DIVISION OF EXPENSES TO BE MET.

The expenses of furnishing water may be divided into two classes, capacity expenses and output expenses. Output expenses are, as the name indicates, expenses directly dependent upon the output. There are certain other expenses which are not dependent upon the output, but which are necessary if a plant is to be ready to serve at all times. These expenses are called capacity expenses. Maintenance of distribution mains, reservoirs, tanks and standpipes is an illustration of a capacity expense while the cost of steam generated is largely an output expense. When expenses are encountered partaking of both capacity and output expenses they may be divided between the two in the ratio that they go to make up each expense.

The method of arriving at the distribution of expenses is as follows: The current operating expenses are first divided into capacity and output expenses and the percentage that each is of the whole is determined. Interest, depreciation, profit and taxes are regarded as overhead expenses and the same ratio is applied to them as to the operating expenses. The addition of the capacity and output operating expenses to the same expenses determined for interest, profit, depreciation and taxes gives the total capacity and output

expenses.

(a) CAPACITY EXPENSES.

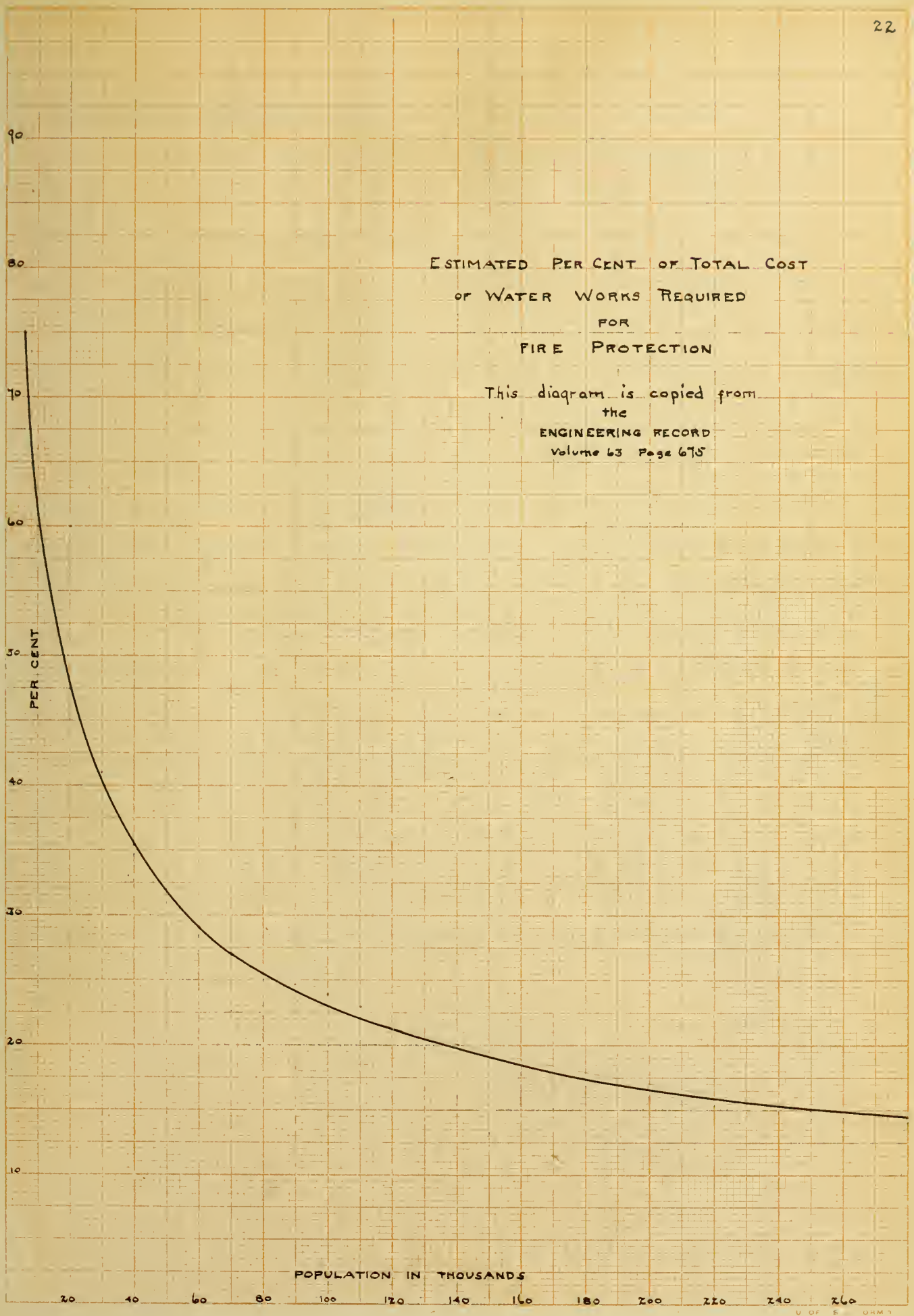
The capacity expenses must now be divided with respect to the public and the private consumer. It is a well-known fact that water plants which are called upon to serve both public and private demands must be built in an essentially different manner from those merely designed to serve domestic uses. The great differences in construction is due to the fact that waterworks serving municipalities must stand ready at any time to handle serious fires and must therefore be designed with larger mains, greater storage capacities, more powerful pumps and greater reserve powers. The usual method of determining the cost of this fire protection is to analyze the existing plant and apportion each item between two hypothetical plants, one existing for fire service and the other for domestic service. Donald H. Sawyer in a thesis written in 1902 on "Hydrant Rentals" adopted the following method of determining what fire protection costs. He found the cost of the distribution and pumping systems for four different sized towns for domestic service alone, and then found the costs of these systems for both fire and domestic service. The difference between the two is directly chargeable to fire protection.

Probably the most extensive and general study of this question is that made by Messrs. Leonard Metcalf, Emil Kuichling and W. C. Hawley and presented by them before the American Water Works Association. They state that while it has been assumed that approximately one half of the cost of water works furnishing fire protection as well as domestic and industrial service is involved in the cost of fire protection, yet this is probably true of only certain sized towns and that the percentage is really dependent upon the size of

the town. From data based on estimates submitted in waterworks valuations they have plotted the curve shown on the following page representing the judgment of the authors as to the approximate percentages of the total cost of the water works involved by the requirements of fire protection service. It is noticeable that the cost of the portion of the water works plant involved by fire protection service is sixty to eighty per cent of the whole for towns less than 5,000 population and for towns of 100,000 population it is only twenty-five per cent of the whole. When it is determined what relation should exist between the cost of the plant for fire protection and for domestic service, then the capacity expenses should be divided in this ratio.

(b) OUTPUT EXPENSES.

The apportionment of the output expenses between the public and the private consumer is a much easier matter than the apportionment of the capacity expenses. The consumption of the public and domestic users is the basis, consequently the output expenses should be so divided that each pays in proportion to the amount of water used.


ESTIMATED PER CENT OF TOTAL COST
OF WATER WORKS REQUIRED
FOR
FIRE PROTECTION
This diagram is copied from
the
ENGINEERING RECORD
Volume 63 Page 675
PER CENT
90
80
70
60
50
40
30
20
10
POPULATION IN THOUSANDS
20
40
60
80
100
120
140
160
180
200
220
240
260

B. PRIVATE CONSUMERS RATES.

Having determined what the private consumers, as a whole, should pay it is necessary to ascertain how this payment should be divided between individual users. The installation of meters by water companies is becoming more and more prevalent and it seems only a question of time until meters will be universally used. For this reason rates will be discussed only from the standpoint of metered consumers. The consumers' rates will be made up of three items: A meter charge, a service charge and an output charge. The meter charge includes interest, depreciation and maintenance of meters and should vary with the size of the meter. A meter reading charge is also included under the meter charge and will be the same for each meter. It is found by dividing the total cost of such service by the number of meters. The service charge should be equal to the capacity expenses divided by the number of consumers. Although this is not exactly fair to all classes of consumers since some of them may necessitate a larger plant outlay than others yet it seems the only practical way unless very definite data has been obtained regarding the consumption of each customer in the past. The output charges should be found by dividing the output expenses by the total number of gallons consumed.

IV. TYPICAL CASE.

The following case is given illustrating the method of determining equitable water rates. Although the data is assumed, the values used might be typical of many towns of this size.

Assumed data.

Population	30,000	
Miles of mains	60	
Consumption-gallons yearly	(Public	200,000,000
	(Private	275,000,000
	(Waste	180,000,000
Present valuation		$ 750,000
Number of consumers		6,100
Number of meters		4,500
Yearly operating expenses		$ 25,000

Calculated data.

Interest and Profits.

Allow 7 % for this item. 7% of $750,000 = $52,500

Depreciation.

Allow 2 % for this item. 2% of $750,000 = $15,000

The division will first be made between the capacity and the output expenses. The Wisconsin Railroad Commission stated that in the majority of cases the capacity expenses will run from 60 to 65 per cent of the total expenses. In this determination 65 per cent has been used.

DIVISION BETWEEN CAPACITY AND OUTPUT COSTS.

	Total	Capacity		Output	
		Percent	Amount	Percent	Amount
Operating Expenses	$25,000	65	$16,250	35	$ 9,750
Interest & Profits	52,500		34,125		18,375
Depreciation	15,000		9,750		5,250
Total	92,500		60,125		32,375

The capacity expenses are now divided between the public and the private consumers. The percentage used was obtained from the graph shown on page 22 .

APPORTIONMENT OF CAPACITY EXPENSE.

	Municipal	Private
Per cent	41	59
Amount	$24,651.25	$35,473.75

The output expenses are now apportioned between the public and the private consumer on the basis of the amount of water consumed by each.

APPORTIONMENT OF OUTPUT EXPENSES.

	Municipal	Private
Gallons consumed	200,000,000	275,000,000
Per cent	42.1	57.9
Amount	$13,629.90	$18,745.10

The total municipal charge is the sum of the output and capacity charges.

$13,629.90 plus $60,125.00 gives $93,754.90.

APPORTIONMENT OF EXPENSES BETWEEN PRIVATE CONSUMERS.

The expenses will now be apportioned between the private consumers. The meter charge will be determined first.

METERS.

Interest and depreciation on investment of

$55,000 at 8 %	= $ 4,400
Maintenance	= $ 600
Meter reading charge	= $ 500
Total	$ 5,500

It is assumed that there are seven different sized meters in use in this particular town varying from a 5/8 inch meter up to a four inch meter. In order to reduce all meters to the same basis the 5/8 inch meter is used as the standard and all of the other meters are compared to this one. A factor is determined for each meter by comparing the cost of the meter with a 5/8 inch meter and this factor multiplied by the number of meters of that class gives a figure which represents the part that this particular size of meter is of the total number of meters. The unit charge is found by dividing the meter charge by the number of units found in the process just mentioned.

Size of Meter	Value of Meter	Factor	Number of Meters	Factor Times Number of Meters	Unit Charge 5/8" Meter	Unit Charge Times Factor
5/8	$ 8.40	1.0	4,127	4,127.	1.02	1.02
3/4	12.60	1.5	300	450.		1.53
1	16.80	2.0	40	80.		2.04
1 1/2	30.00	3.58	15	53.7		3.65
2	50.00	5.96	10	59.6		6.08
3	90.00	10.72	5	53.6		10.93
4	175.00	20.80	3	62.4		21.21
Totals			4,500	4,886.3		

The meter reading charge must now be found and added to the above charge. This charge is determined by dividing the total cost of meter reading by the number of meters.

$$\$ \frac{500.00}{4500} = \$ 0.111$$

METER CHARGE

Size of Meter	Meter Charge	Meter Reading Charge	Total Meter Charge	Rate For 1/2 Year
5/8	$ 1.02	$ 0.11	$ 1.13	$ .50
3/4	1.53		1.64	.75
1	2.04		2.15	1.00
1 1/2	3.65		3.76	1.75
2	6.08		6.19	3.00
3	10.93		11.04	5.50
4	21.21		21.32	10.50

SERVICE CHARGE.

The service charge is found by dividing the private consumers share of the capacity charge less the total meter charge by the number of private users. The capacity charge less the total meter charge is equal to

$$\$ 35,473.75 - \$ 5,500 = \$ 29,973.75.$$

$29,973.75 divided by 6,100 gives a value of $ 4.90. A consumer charge of $ 2.50 for one-half year seems equitable since the fixed meter charge for one-half year is slightly below the actually determined value.

OUTPUT CHARGE.

The output charge for private consumers is now determined by dividing the total private output expenses by the number of gallons used by the private consumers.

$$\$ 18,745.10 \div 275,000 = \$ 0.0681 \text{ per 1000 gallons.}$$

It would seem safe therefore to adopt a rate of $ 0.07 per 1000 gallons.

The following table gives a schedule of rates for any number of consumers, or families, up to ten on one meter. The charge for one person is the sum of the meter charge and the consumer charge. The charge for two persons is the one meter charge plus two consumer charges.

SEMI-ANNUAL METER RATES.

Size of Meter	Number of Consumers on Meter.									
	1	2	3	4	5	6	7	8	9	10
5/8"	$ 3.00	$ 5.50	$ 8.00	$10.50	$13.00	$15.50	$18.00	$20.50	$23.00	$25.50
3/4	3.25	5.75	8.25	10.75	13.25	15.75	18.25	20.75	23.25	25.75
1	3.50	6.00	8.50	11.00	13.50	16.00	18.50	21.00	23.50	26.00
1 1/2	4.25	6.75	9.25	11.75	14.25	16.75	19.25	21.75	24.25	26.75
2	5.50	8.00	10.50	13.00	15.50	18.00	20.50	23.00	25.50	28.00
3	8.00	10.50	13.00	15.50	18.00	20.50	23.00	25.50	28.00	30.50
4	13.00	15.50	18.00	20.50	23.00	25.50	28.00	30.50	33.00	35.50

To the above charge would be added $0.07 per 1000 gallons for all water used.